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RESEARCH IN SOME ASPECTS OF DISEASE ASSOCIATED WITH THE FIELDS OF ZOOLOGY, ENTOMOLOGY AND PARASITOLOGY[1]

IN no other domain of medical science has such progress been accomplished within the past two decades as in that of medical zoology, entomology and parasitology, and it is significant that the great majority of the discoveries upon which this progress is based have been made in connection with the elucidation of the etiology and methods of transmission of the tropical infectious diseases. For, the abolition and prevention of a number of these diseases, obviously based upon such discoveries, has constituted one of the great triumphs of the science of medicine. Discoveries of the relation of insects to disease have in some instances revolutionized our attempts to prevent and control some of the most devastating infections. In fact, it is very largely through the discoveries of the cause and methods of spread of the serious epidemic diseases that preventive medicine has progressed from a blundering art of forty years ago to its present important position among the medical sciences.

However, while very great progress of this nature had been made in earlier years by the recognition of the value of vaccination against smallpox by Jenner in 1796, and of the discovery of the causative organisms of tuberculosis, typhoid fever and Asiatic cholera from 1880-1883, scientific advances of an entomological nature in connection with disease materialized only later and did not begin to be made for nearly another decade. Thus, although man in his conquest and discovery of new territory made through various explorations both by sea and land during the fourteenth to the nineteenth centuries gradually acquired through his conflict with devastating disease consider-

[1] Read at the annual meeting of the American Association for the Advancement of Science, December, 1922.

able epidemiological evidence, and became familiar with certain popular beliefs and even sage suggestions intimating that several infectious diseases might be spread through the agency of insects, it was not until 1879 that Manson demonstrated that the mosquito *(Culex fatigans)* served as a host for the parasite *Filaria bancrofti,* and that this parasite underwent at least a portion of its life-cycle therein. In the following year Laveran discovered the parasite of malaria, and in 1893 Theobald Smith demonstrated that the disease Texas fever was transmitted by the cattle tick *(Boophilus bovis).* Following these discoveries there came a series of brilliant investigations which have led to much of the remarkable progress recently made in preventive medicine. In spite of the great importance and far-reaching application of many of these discoveries which have related to practically all of the important and widely prevalent tropical infections, lack of time will permit only a very brief reference to some of those which are of greater significance to-day.

Obviously, there are many interesting problems relating to even those fields of medical zoology and entomology already well trodden that still await solution. Considering for a moment the aspect of diseases caused by protozoa, it is of interest to recall that while the parasite causing visceral leishmaniasis or kala azar was discovered in 1903, and there has been published since that time much experimental evidence in favor of the transmission of the disease in India by *Cimex rotundatus,* and on the shores of the Mediterranean by *Pulex cerraticeps,* the most recent work has thrown considerable doubt upon the transmission of leishmaniasis by either of these insects. Particularly from the investigations of Patton we know that the parasites ingested from the peripheral blood of cases of kala azar develop into a flagellate in the stomach of *Cimex rotundatus,* and may persist for as long as forty-one days, very much as Rogers has shown that they may in the blood agar culture tube. Patton suggests that by the crushing of the infected bedbug upon the skin human infection occurs. However, it would appear that we are to-day no nearer the final solution of the problem of the transmission of visceral leishmaniasis than we were ten years ago. Also, the relationship between the human disease and the similar associated canine leishmaniasis which occurs particularly in the Mediterranean and Caspian Sea regions still requires an explanation in view of the absence of the latter from other important endemic centers such, for example, as India. A serum test for the diagnosis of kala azar, known as the "formol gel" test has recently been described. The test is performed by the addition of several drops of commercial formalin to about 1 c.c. of clear serum. In a case of kala azar the mixture becomes viscid immediately and within a few minutes jellied and opaque like the white of a boiled egg, while with other diseases, such as malaria and syphilis, the reaction is delayed for a considerably longer period, up to twenty-four hours. A wider application of the test and of its significance is, however, desirable.

Recent experiments have demonstrated that *Phlebotomus paptasii* can harbor for at least three days the virus of Oriental sore, and that such flies when crushed and rubbed into a scarified area of the skin will after a proper incubation period produce a lesion in which leishmania are demonstrable. However, it is only by further investigations that the origin of the virus in this fly, and whether it is derived from a reservoir or is a natural flagellate infection of the fly, as well as the exact mechanism of infection in nature, can be determined. There is little definite evidence that the gecko, *Tarentola mauritanica,* may act as the reservoir for the virus of Oriental sore, although this has been suggested on the ground that this lizard is ravenously fed upon by sand flies, and that in certain regions fifteen per cent. of the geckos contain a flagellate of the leptomonas type.

Very interesting are the observations which have recently been made regarding the occurrence of flagellates of plants, chiefly euphorbias, and the suggestions that they may be a natural source of insect infection. Laveran and Franchini have reported the successful inoculation of healthy euphorbias of two species with pure cultures of *Herpotomas stenocephali* var. *Chattoni,* and have also infected white mice with latex of *Euphorbia nereifolia* naturally infected with leptomonas, subsequently finding leishmaniform parasites in the

blood of the mice that survived the experiment. Franca previously had failed to infect animals with *Leptomonas davidi* from latex of euphorbias, but he did not experiment with the insect-borne strain of the parasite.

A very great advance has been made in the discovery of the value of tartar emetic in the treatment of leishmaniasis. Formerly the death rate from kala azar in India in untreated cases varied from seventy to ninety-eight per cent., while through the use of repeated intravenous injections of from two to ten c.c. of a sterile one per cent. solution of tartar emetic the mortality has been very greatly reduced. Thus Dodds-Price has reported during the past year a series of over two thousand injections of tartar emetic in the treatment of cases of kala azar with sixty-seven per cent. rate of recoveries. However, this drug is very toxic, and its use in human beings is attended with some danger. A number of reliable investigators have reported deaths due to poisoning in the doses recommended. In some of the fatal cases fatty degeneration of the heart, liver and kidneys was noted. Much that we should know in regard to tartar emetic is still undetermined. The formula of it is even not certainly known. No satisfactory method of preparing a suitable stable solution for injection has been discovered, and it is not known exactly what chemical change occurs when the drug is submitted to sterilization in the autoclave. It is so irritating locally that it can not be used advantageously except by intravenous injection. Its method of excretion from the body is also not certainly known, and whether it remains as antimony potassium tartrate in the circulating blood, or whether it combines with a constituent in the body of the patient before destroying the parasite, has also not been ascertained. Since tartar emetic has proved to be not only of so great value in this disease but also in the treatment of bilharziasis, trypanosomiasis and granuloma inguinale, it is highly important that we should have more accurate pharmacological knowledge regarding it. Weiss and Hatcher have recently shown that tartar emetic (antimony and potassium tartrate) induces vomiting reflexly through local irritation after its introduction into the stomach or duodenum, and that it does not cause emesis in the cat or dog when it is applied directly to the vomiting center described by Thumas and which lies in the floor of the fourth ventricle. It is particularly on account of the powerful destructive and irritant action upon the gastro-intestinal tract that the drug can not be satisfactorily given by the mouth in the treatment of infectious processes. Intravenous injections of tartar emetic induce vomiting after varying intervals of time largely dependent on the size of the dose. This emesis is not prevented by the removal of the gastro-intestinal tract, or by the removal of the celiac plexus and simultaneous cutting of the vagi below the diaphragm, but it is profoundly influenced by cutting these nerves in the neck or by paralyzing the vagus endings with atropin. It is also apparently abolished by severing all nervous connection between the heart and centers, by removal of the stellate ganglia and cutting the vagi in the neck in the cat.

Of the recent compounds of antimony, p-acetyl-amino-phenyl-stibinate (stibacetin) appears in some ways to be the most favorable for use, and Brahmachari has found that urea stibamine is a much safer antimonid for use in the treatment of kala azar than tartar emetic or other antimonyl tartrates. There are many difficulties in employing aromatic compounds of antimony which are with a few exceptions non-crystallin and the construction of an efficient less toxic and stable preparation of antimony still remains one of the most urgent problems of tropical medicine. Further work upon this subject is being pursued in my department at the Harvard Medical School.

With reference to malaria, while approximately forty years have passed since the species of plasmodia infecting man were described, there is still no complete agreement as to whether there are really three or only one polymorphic human species. Both Grassi and Plehn believe and support the idea that there is but one parasitic species, the form of which changes with the season. While the existence of double or even in some instances of triple infections with the three species might explain many of the apparent transitions in form from one to another, there is still considerable dif-

ference of opinion on the subject. It is generally admitted from the classical experiments of Grassi, Bignami and Bastianelli performed in 1898 that only certain species of anophelinæ may transmit human malaria, and also that *culex* and *stegomyia* are not carriers of malaria, but there has been no satisfactory scientific explanation of why this is so. These facts can not be explained upon the ground of geographical distribution, numerical prevalence, zone of flight, length of life, food supply or other different habits of these mosquitoes. In this connection it is interesting to note that the different species of anopheles capable of carrying malaria and playing a large rôle in nature in this respect come from the most divergent groups of the sub-family. In Europe and northern America, according to the classification of James, the relatively primitive protoanophelines are the active agents. In the new world an offshoot of this the true cellia group are the carriers. In the old world the totally distinct deutero-anophelines furnish practically all the carriers, while in Australia and New Guinea the neo-anophelines, an offshoot of the same stock, come into prominence. Many species of *anopheles, culex* and of *stegomyia* will transmit *Filaria bancrofti*, and Ross and others have demonstrated the full development of *Proteosoma precox* in species of *culex*, particularly *fatigans*.

To-day we know that *Hæmoproteus noctuæ* (Celli and San Felice) and *H. Syrnii* (Mauer), parasites of avian anemia, are also transmitted by *Culex pipiens* (Linnæus) and *Culisetta annulata Schrank* (Theobóldi). However, no one has demonstrated the entire development of the human malarial parasite in *culex* and it is generally believed that there is no evidence of the existence of malaria without some of the anophelinæ. Daniels is inclined to suspect that the ædinæ found in jungles may transmit malaria in such localities, but this has not yet been determined by experiment.

This contraction of malaria in uninhabited jungles has again raised the question of whether some other animal than man may not also act as an intermediate host for the human malarial parasite.

Donovan, having found *Plasmodium pithici* in the orangoutang and *Plasmodium kochi* in several species of monkeys, made the attempt to determine whether the infection in human beings in the jungle might not be attributable to infection from monkeys. He, however, found no human plasmodia in seventy-six *Macacus sinicus* or in ten *Presbytis priamus* from the forests near Madras, but he detected a parasite very like *Plasmodium vivax* in the Malabar squirrel, *Ratufa indica malabarica*. In this connection one may recall that all specific human parasites must have had an origin outside of the human species, and probably pursued their evolution independent of man. Nevertheless, if one finds a protozoan parasite in an animal even extremely similar to one affecting man, it would be precipitous to conclude that the two parasites are identical or had the same origin without the additional proof that the animal may be infected with the human species. Manson suggested that cave-dwelling bats may have been the original source of human malaria. However, attempts to infect flying foxes or fruit-eating bats of the species *Cynonycteris straminea* with *Plasmodium falciparum* and *P. malariæ*, both by specific inoculation and by exposing them to the bites of *anopheles*, have failed. A number of investigators have observed *plasmodia* in the higher apes, and Mesnil and Roubaut have succeeded in infecting chimpanzees with both benign and with malignant tertian malaria by direct inoculation, but not with bites of *Anopheles maculipennis*. Both infections died out shortly and naturally.

Reichenow believes that he has found in the gorilla and chimpanzee in West Africa all the forms of *plasmodia* which infest man, and he confidently asserts that the anthropoid apes are as sure a source of danger to Europeans living in those parts as are negroes. Still more recently Blackloch and Adler in a chimpanzee in West Africa have also found both small rings and crescents morphologically indistinguishable from *Plasmodium falciparum* and apparently identical with the parasite described by Reichenow. Further confirmation of this work is desirable.

Some work of considerable significance has recently been performed which may help to explain the condition known as dormant or latent malaria and its relation to relapse.

Grassi and Schaudinn attribute the origin of relapse to pathogenesis of macrogametes, and Ross to the persistence of a few schizonts. Whitmore in a study of bird malaria has shown that the blood of infected canaries remains infective by injection for at least twenty-nine months after parasites have ceased to be discoverable in the blood by a microscopic examination.

E. Sargent had also observed persistent infection after apparent disappearance (as determined by microscopical examination) of the parasite from the bird's blood, by demonstrating that its blood is still infective for *culex*.

Until very recently comparatively little was definitely known regarding the time that *anopheles* might remain infective after biting a malarial patient. A number of observers had claimed that *anopheles* generally lose their power of infection after hibernating, and that those which have hibernated during the winter are not able to produce infection in the spring unless they themselves become reinfected.

Wenyon, however, has recently shown that if infected *anopheles* were placed in an ice chest between 9° and 12° C., oocysts already formed became degenerated in every case. If, however, the temperature was only lowered to that of the laboratory, development of the oocysts could be temporarily arrested for as long a period as three weeks and then revived again when the mosquitoes were placed in the incubator.

Mayer infected *culex* with the *proteosoma* of birds and found five weeks later that not only the insects' salivary glands but also the muscles of the body and appendages of the palpi contained numerous sporozoites. Fifty-two days after the infective feed, isolated sporozoites could be detected in the muscles. This suggests that under certain conditions the sporozoites may persist for longer periods in these locations than in the salivary glands.

Finally, Mayne has shown that *plasmodia* of malaria were detected in the salivary glands of five specimens of *Anopheles punctipennis*, kept at a temperature of 44° to 78° F., from sixty-eight to ninety-two days after infection, and that *plasmodia* of malaria were proved to be viable by inoculation into a human host by the bite of a mosquito which had been infected fifty-five days previously. Thus under certain conditions the carriage of malaria through the winter by the mosquito would seem to be a possibility.

It is almost certain that hereditary infection of the mosquito does not occur. Schaudinn claimed to have observed sporozoites of the benign tertian parasite in the ovaries, but this observation has not been substantiated. Mayer and Muhlens both found sporozoites in the vicinity of the ovaries in infected *culex* and *anopheles*, but not within these organs.

Great confusion still exists in regard to the subject of immunity in malaria. Complete natural immunity for man depending on the presence in the blood of substances which prevent any development of the naturally inoculated virulent human malarial parasites in considerable number is doubtful, and the relationship of partial natural immunity to latent infection in which symptoms are long delayed beyond the usual incubation period of the disease has not been satisfactorily explained. On the other hand, partial immunity or tolerance of the infection without evident symptoms of disease is apparently generally acquired gradually by frequent infections and reinfections repeated continuously during a number of years. Such infections include the malarial carriers. Whether the acquired immunity ever becomes sufficient by the production of specific antibodies unaided by drugs to destroy all the parasites, and to sterilize the patient, is still questionable. The brothers Sergent, in studying the immunity of canaries to avian malaria, found that the normal immunity rate in 965 canaries was 0.72 per cent. By injecting blood taken from a canary during the incubation period after an experimental infection, the immunity rate in canaries could be raised to 21.3 per cent. in 61 canaries. Finally, by the injection of sporozoites kept in vitro for twelve to forty-eight hours, the immunity rate in 24 canaries could be raised to about 30 per cent. Further extension of these interesting experiments is also highly desirable. Cremonese believes with others that as mosquito infection with malaria is greatest in the autumn, consequently primary infection must in the main be then acquired. He further believes that the first evidence of symptoms of the malarial attack occurring in the spring is

due to the effect of climate acting upon humoral antibodies, in cases of long latent malarial infection. Primary latency is held to be the rule in malaria and natural immunity to depend upon the parasites acting as antigen, but only as long as they are extracorpuscular. Once the parasite becomes intracorpuscular, complement is held to be powerless to unite with antibody. In connection with this subject the influence of sunlight in the spring as well as of ultraviolet rays upon the development of latent malarial infection and relapse has recently been emphasized by Whitmore.

With reference to quinin, still the most specific drug in the treatment of malaria, the brothers Sergent found in experiments in which *Plasmodium relictum* was injected into canaries, and daily injections of quinin given, in only one case was there evidence of the development of a strain resistant to quinin, this character being retained in full during its passage through two other canaries and in lessened degree through a third. It appeared in a canary kept quininized for nine months without symptoms, these, then, appearing in spite of the continuation of the quinin. From twelve experiments they conclude that to administer prophylactic quinin before there is risk of infection is useless. Macht has recently shown that the toxicity of quinin sulphate is much greater when injected into frogs if these animals are exposed to sunlight than it is when they are kept in the dark. Further experiments revealed that it was the light waves from the violet end of the spectrum that were the most effective in increasing the toxicity of quinin and quinidin. In other experiments the rays of an electric arc lamp were utilized instead of sunlight, and the same potentiation in toxicity was qualitatively noted. It would be of interest to ascertain whether this increased toxic action is associated with the property of fluorescence.

The relationship of the wild game to human sleeping sickness and the controversy as to whether human trypanosomiasis is communicated to man by *Glossina morsitans* that has been infected with trypanosomes from feeding on wild animals, is far from being settled. However, the recent experiments of Taute and Huber in which Taute inoculated himself and Huber and one hundred and twenty-nine natives with blood containing virulent *Trypanosoma brucei* from naturally infected animals without obtaining a single human infection go far indeed towards demonstrating that *Trypanosoma brucei* of Nagana and *Trypanosoma rhodesiense* of human trypanosomiasis are not identical.

A large amount of research has been recently performed regarding the chemotherapy of trypanosomiasis. Pearce has recently called attention to the good results obtained with tryparsamide and exceedingly favorable reports have been given of the efficacy of a new preparation known as "Bayer 205" in the treatment of trypanosomiasis both in man and animals. The preparation is stated to be much more efficient for this purpose than atoxyl and antimony, and much less toxic. However, it is not harmless for man since it has an effect upon the blood and the kidneys, in moderately large doses causing destruction of erythrocytes, anemia and albuminuria. Albuminuria has also been observed in man sometimes after quite small doses. It usually does not appear until some days after the injection of the drug. The substance circulates in the blood for weeks and even months, so repeated doses must have a cumulative effect. For man a ten per cent. solution has been recommended, 0.5 gram being given at the first dose, and, if this is well borne, twenty-four to forty-eight hours later one gram intravenously, up to three grams within a week. After this there should be at least a fourteen-day interval with a careful examination of the urine. Many of the cured animals remain immune against subsequent infection for weeks and months. Pfeiler has treated horses suffering with dourine with this preparation. Some of the animals have apparently been cured, but in other cases the treatment has failed. The serum of healthy rabbits previously injected with this drug is therapeutically active, and it is possible to cure rats and mice infected with *Trypanosoma brucei* with such rabbit serum removed up to fifty-one days after the injection of "Bayer 205." The drug perhaps combines with some element in the serum before directly killing the trypanosomes. If this is substantiated it would appear that "205" is a protoplasmic poison which acts in

this connection in a somewhat similar manner to several other chemotherapeutic preparations recently investigated. Thus it has been suggested that an organic compound containing arsenic, as salvarsan for example, does not itself directly kill the spirochætes, but that the cells of the patient must in some way cooperate, perhaps by oxidizing this substance. A somewhat similar action has been suggested for emetin. Dale and Dobell found that when emetin is applied to fresh amœbæ taken from the dysenteric lesions, it has a surprisingly weak action on these organisms, and that they were still motile after contact for two hours in a one per cent. solution of emetin hydrochlorid. Dale then prepared certain derivatives of emetin and found that di-methoxy-emetin was ten times as poisonous for the amœbæ and not nearly as poisonous for the animals (cats) as emetin, but it had no therapeutic effect whatever. Hence, it was concluded that the curative action of these alkaloids was proportional not to their direct poisonous action on the amœbæ, but to their poisonous action on the patient, and it is suggested that the body of the patient must play an essential and perhaps a primary part in the killing of the parasite. However, the experimental difficulties in connection with the chemotherapeutic study of emetin in cats infected with amœbæ are considerable, and it is exceedingly desirable that the problem should be approached in other ways. The further study of the nature of the reaction between these chemotherapeutic agents and the cells of the patient and the final action upon the parasite is exceedingly important.

A vast amount of research has in recent years been carried on in relation to the spirochætal diseases and their methods of transmission. The exact systemic position of these microorganisms has been productive of considerable controversy since Schaudinn in 1905 discovered the species specific for syphilis and named it *Spirochæta pallida*. However, their zoological position has not yet been satisfactorily determined and there is still considerable dispute as to whether the spirochætæ should be classified with the protozoa or with the bacteria, or in an intermediate kingdom, the protista. Recent investigations show that they possess a firm but flexible periplast and multiply by both longitudinal and transverse division. By differential staining they may be seen to possess bars or rods which stain deeply and assume a chromatin tint, while some species show a non-undulatory membrane. According to Balfour, Leishman and others, a resting or resistant stage, the granular stage, constitutes an important phase in the life-cycle of the spirochætes, and is supposed sometimes to explain the infection of the offspring of the intermediate hosts, ticks or lice, and also the human relapses when the blood stream is flooded with parasites, developed apparently from the granules located in the internal organs. While the nature of the chromatinic granules produced by spirochætes has been much discussed, there is still not unanimity of opinion regarding them. Marchoux and Couvy, Wolbach and Betances consider the granules or coccoid bodies to be degeneration products. Leishman, Bosanquet and Fantham, however, do not coincide with this view. Leishman believes that he has seen young spirochætes apparently attached to a granule clump suggesting what might be interpreted as growth of a spirochæte from a granule.

Sergent and Foley have recently shown that monkeys can be infected with human blood containing no visible spirochætes, and they believe that the virus of recurrent fever may exist in the blood of man and also in the louse in a very minute form. The existence of this cycle or form, they declare, is an argument in favor of the relationship of the spirochætes of relapsing fever to the protozoa.

Todd believes that it is only by definitely seeing granules grow to comma forms, and commas to spirochætes, that the development of spirochætes from granules can be demonstrated. Balfour has more recently observed a development of some of the granules from the malpighian tubes in ticks into spirochætal-like forms, but he has been unable to trace a complete cycle of development in the tick. Possibly by the continuous observation of these organisms kept at favorable temperatures in a moist chamber, and examined by direct illumination and also with the darkfield, further information regarding this question may be obtained.

Since Schaudinn's discovery of *Spirochæta pallida*, five other important species of *spirochætæ* causing disease in man have been de-

scribed: *S. pertenuis* by Castellani in 1905 as the cause of yaws, *S. bronchialis* by Castellani in 1907 as the cause of bronchial spirochætosis, *Leptospira icterohæmorrhagiæ* by Inado and Ido in 1914 as the cause of hemorrhagic jaundice, *Spirochæta morsus murium* in 1915 by Futaki as the cause of rat-bite fever, and *Leptospira icteroides* by Noguchi in 1919 as the cause of yellow fever. *Spirochæta schaudinni,* which has been described as the cause of ulcus tropicum, can hardly be differentiated morphologically from *Spirochæta refringens* discovered by Schaudinn and found by him in syphilitic lesions of the external genitalia and in open ulcers of the skin. While there are some suggestions in the literature indicating the pathogenicity of *Spirochæta eurygyrata* Werner in the intestine in man, the recent investigations would indicate that further studies on this subject are desirable. Hogue did not find the coccoid bodies described by Porter as a means of transmitting this organism, but she was able to cultivate this spirochæte in a medium consisting of 15 c.c. of 0.85 sodium chlorid solution and 0.3 c.c.. of sterile serum water, with a p_{H_7} reaction, the tubes being covered with paraffin oil.

There are a number of recent reports in the literature calling attention to the prevalence of the condition known as bronchial spirochætosis. *Spirochæta bronchialis* can hardly be distinguished structurally from *Spirochæta refringens.* There is considerable evidence which shows that the spirochætes in the sputum in this condition are really oral spirochætes which have found a suitable medium in the bronchi, particularly in tuberculosis and other pathological conditions of the lung, and there is not general agreement regarding the acceptance of bronchial spirochætosis as a distinct disease.

Vincent believes as do a number of others that the lung condition in spirochætal bronchitis is due to invasion of the bronchi by the same organisms which occur in Vincent's angina, and that *S. bronchialis* is identical with *S. vincenti.*

It is interesting to note that with reference to transmission only one species, *Leptospira icteroides,* has been demonstrated to be transmitted by insects, *Stegomyia calopus. Spirochæta bronchialis* is said to be transmitted from man to man by coccoid bodies or granules through droplet infection in coughing, the coccoid granules being more resistant to drying than the spirochætes. With reference to the different species of spirochætes which have been described for relapsing fever in different parts of the world, it seems very doubtful if these various forms really constitute distinct species, since the experimental methods employed for their differentiation and based upon immunity reactions are not entirely reliable for the separation of species of these spirochætes. Nevertheless, in the literature of the past year one finds two more species described as new and different from those hitherto described. Still more recently Blanchard and Lefrou have reported a spirochæte in the blood in blackwater fever, *Spirochæta bilio hemoglobinuriæ,* and Couvy has observed another species in the prefebrile period of dengue fever.

Kasai, by inoculation experiments on rats, mice and guinea pigs, and serological tests involving Pfeiffer's reaction, has concluded that the smaller spirochætal forms obtained from cases of rat-bite fever and the slightly larger forms occurring naturally in rats and mice are identical.

Hoffmann has not accepted the differentiation between *Spirochæta icterohæmorrhagiæ* and *Spirochæta icteroides.* The thorough investigation of the histological and hematological appearances in a large series of guinea pigs infected with *Leptospira icteroides* gave results absolutely identical with those found in another series of animals infected with *Leptospira icterohæmorrhagiæ,* and there were no clinical, pathological and anatomical differences in the two experimental infections, though attempts to differentiate these organisms by the immunity reactions were not included in this study.

Borges in a number of cases of yellow fever occurring in Bahia tested the serum with *Leptospira icteroides* by the Pfeiffer phenomenon and found negative results. However, Noguchi in a still more recent publication believes that these pathogenic *leptospira* are by no means identical, as can be proved not only by their immunological but also by their pathological properties. *Leptospira icteroides* is predominantly icteronephritic, with a marked tendency to produce fatty degeneration of the

parenchymatous cells of the liver and kidney. The hemorrhages in mucous membranes are more pronounced in experimental infections with *Leptospira icteroides* than those resulting from *Leptospira icterohæmorrhagiæ*. He believes that the two diseases yellow fever and haemorrhagic jaundice are essentially similar, though caused by two distinct species of the genus *Leptospira*, just as syphilis, yaws and venereal disease of rabbits are three diseases caused by three morphologically indistinguishable species of the genus *Treponema*.

Among the many important advances that have recently been made in our knowledge of medical helminthology, and that have had an important influence in preventive medicine are the recent elucidations of the life-history of the trematodes *Schistosoma japonicum, hæmatobium* and *mansoni, Paragonimus westermanii* and *Clonorchis sinensis;* of *Dibothriocephalus latus* and *Spargonum mansoni;* of *Filaria (Loa) loa*, and of *Ascaris lumbricoides*. The schistosomidæ have been shown to be digenetic trematodes, and certain snails, particularly *bulinus* for *Schistosoma hæmatobium*, of *planorbis* for *Schistosoma mansoni* and *blandfordia* for *Schistosoma japonicum*, have been demonstrated to act as the intermediate hosts. The miracidia of these parasites hatch from the egg in water after entering these snails, develop into cercariæ which, being passed from the snail into the water, may infect man either through the normal skin as when bathing or through the mucous membranes as in drinking infected water. In the case of *paragonimus* there are two intermediate hosts, the first consisting of mollusks of the genus *Melania* in which the cercariæ are developed and from which they pass into the water and then either enter man directly or pass to the second intermediate host (the crustacean) consisting of species of crabs of the genus *Potamon* or *Eriocheir*. The cercariæ may migrate through the tissues of the crab and become discharged again into the water from the gills. Infection of man would appear to depend then not necessarily upon the consumption of uncooked crab or crawfish, but from the free larvæ which, while they can not penetrate normal skin, may enter from the water through the mucous membranes of man or through wounds in the skin. In the life-history of *clonorchis*, the two intermediate hosts have recently been shown to be the molluscan *Bythinia striatula*, from which the cercariæ pass to and encyst in edible fish, particularly *Pseudorasbora parva* and *Leucogobio guntheri*, man becoming infected from the ingestion of these fish. The life-cycle of *Loa loa* has very recently been worked out in two species of *Chrysops* in Nigeria, *Chrysops silacea* and *Chrysops dimidiata*, 358 flies experimentally infected having been examined by A. and S. Connal. Development takes place in the muscular and connective tissue, principally in the abdomen of the fly, but also in the thorax and head. The metamorphosis takes ten to twelve days for completion, and is somewhat similar to that of *Filaria bancrofti*.

Yosida has experimentally infested the dog and cat with larvæ of *Sparganum mansoni* of the species found both in the human body and the frog which it chooses as the final hosts. The larvæ belonging to both species developed into an adult worm, having a completely identical morphology. These parasites have often been found infesting dogs and cats, and ducks and chickens which eat frogs may also become infested. Human infection occurs from drinking water harboring the infected cyclops, or from eating insufficiently cooked infected chickens or ducks. Ransom in relation to the migration of the larvæ of *Ascaris lumbricoides* has called attention to the fact that a more or less serious lung trouble known as thumps is a very prevalent malady among pigs, and is caused primarily by *ascaris* larvæ in the lungs. He believes that pulmonary *ascaris* of a more or less severe form occurs also among human beings.

Of less importance, although of scientific interest, are the applications of serological methods involving the complement fixation test in the diagnosis of a number of trematode infections, particularly those due to *schistosomidæ, clonorchis* and *echinococcus* infection.

The efficacy of intravenous injections of tartar emetic in the treatment of bilharziasis, formerly considered incurable, has already been mentioned. Recently Lasky and Coleman have reported upon 1,000 cases of this disease treated with tartar emetic. Of 500 individuals who persevered with the treatment, which aimed to secure a cumulative effect from about twenty grains of tartar emetic, seventy per cent. were pronounced cured. Reference has also already

been made to the toxicity of this drug, and in this series of cases there were ten deaths apparently due to the treatment, though many of the cases were stated to be physical wrecks at the time that the injections were commenced.

While the cercariæ of all the species of *schistosomidæ,* which have been demonstrated to be pathogenic for man and animals hitherto described, have been characterized by forked tails and no eye-spots, Tanabe has recently discovered in Boston a new species of *schistosoma, Schistosoma pathlocopticum,* pathogenic for mice, in which the cercariæ, while fork-tailed, have typical eye-spots. The cercariæ of this schistosome were first discovered in species of *Limnæa* collected from the Charles River near Boston.

A new anthelminthic known as butolan has recently been reported to be particularly efficacious in the prompt cure of oxuris infection and to produce no unfavorable symptoms. This substance is the carbamin-acid-ester of p-oxydiphenylmethane. In the body it breaks up into p-benzylphenol and carbamic acid. The former substance destroys the parasites.

Very interesting are the etiological problems in connection with a number of insect-borne diseases in which the causative organism, while present in the blood, is either of too minute size or in too scanty numbers for its recognition. In this connection I wish to refer briefly to such diseases as typhus fever, dengue fever, pappataci fever, trench fever, African horse sickness, heart-water of cattle, sheep and goats, and tsutsugamushi or kedani disease.

Although the method of transmission of typhus fever by the louse *Pediculus humanus* has been known from the experiments of Nicolle, Rickets, Wilder and others, since 1910, for a number of years the etiology of the disease has been very obscure. It has been possible to transmit the virus by inoculation of the human blood of a typhus patient into monkeys or guinea pigs and to convey it by blood inoculation through long series of these animals. The infection is not fatal in either the monkey or the guinea pig, and the only clinical indications that the infection is transmitted in this way in guinea pigs is by a transient rise in temperature, for these animals usually remain apparently well, continue to eat and act as though in a normal condition. However, if the animal is killed the diagnosis of the infection may be made, as Wolbach and Todd have recently shown, from the histological study of sections of the brain which will reveal the presence of proliferated vascular and perivascular lesions and meningeal infiltrations.

There had not been unanimity of opinion regarding the filterability of the typhus virus. Nicolle, Connor and Conseil inclined to the belief that the virus is filterable because monkeys that had been inoculated with filtrates of blood or of crushed lice that had harbored the virus, while showing no decided temperature reactions, had remained resistant to a subsequent infection of active virus.

Olitsky was unable to filter the virus either from the blood or through Berkefeld V and N candles from the disintegrated tissues of infected guinea pigs. Later, however, he found that in the filtrates of typhus infected tissues of guinea pigs, a substance was occasionally found which produces in these animals thermic reactions, lesions characteristic of experimental typhus, and less frequently immunity to later injections of active virus. However, evidence is given that the filtrates do not contain a living organism.

Recently Rocha-Lima, Topfer and Schuesler, Otto and Dietrich and others have discovered *rickettsia* in lice fed upon cases of typhus fever which occur particularly in the epithelial cells of the intestinal tract of these insects. Wolbach, Todd and Palfrey have also confirmed and greatly extended these investigations. In the meantime, experiments performed by Brumpt and by the writer had demonstrated that lice may be infected with species of *rickettsia* which are not pathogenic for man and that produce no symptoms when such lice are fed upon man. This work has subsequently been confirmed. Thus Noller found *rickettsia* in the louse tick *Melophagus ovinus* of sheep which produced no disease in these animals, and Arkwright, Atkin and Bacot showed that bedbugs, *Cimex lectularius,* heavily and commonly infected with *rickettsia,* produced no symptoms when fed on man.

Besides three species of *rickettsia* in *Pediculus humanus,* two of which have been regarded as pathogenic for man, other species not associated with any disease have been described as

occurring in the bedbug *Cimex lectularius,* the mosquito *Culex pipiens,* in the cat flea *Ctenophalus felis,* the mouse flea *Ctenopsylaa musculi,* in the horse louse *Trichodectes pilosus* and the goat louse *Linognathus stenopsis.* Wolbach has also described as the cause of Rocky Mountain spotted fever an organism in the wood tick *Dermacentor venustus* which perhaps should be included in this group. Finally, during the present year, other species of *rickettsia* have been observed in the dove louse *Lipeurus baculus* and in *mallophaga,* the biting lice of the black martin and of the domestic fowl. While it is not entirely clear that all of these represent distinct species, it would nevertheless appear that the *rickettsia* represent a considerable group of microorganisms related to either the protozoa or bacteria, and that there is only evidence that two of these species are associated in any way with disease. In fact, the evidence shows that one species in the louse and one in the bedbug are not pathogenic for man.

Stevenson and Balfour, after studying the pathology of typhus fever, concluded that there were so many different species of *rickettsia* that they doubt as to their exact nature, let alone their pathological significance.

Phear, in reviewing recent work on the relationship of typhus to *rickettsia,* points out that the experimental evidence establishes a strong case in favor of the view that there is some association of a very close character between the virus of typhus and the *rickettsia* bodies, but, in considering the case for the identity of the two, that much depends on the nature of the granular structures which have been described in the vascular endothelium, and that the investigators would doubtless readily admit that confirmatory observations are necessary before the identity of the intracellular granules with the virus of the disease can be regarded as definitely established. Until an infection is actually produced by a pure culture of *rickettsia,* the etiological significance of these organisms will probably not be admitted by all scientific workers, but the recent work of Wolbach and Todd has gone far towards demonstrating the importance of *rickettsia* in human disease.

Several reports of the successful cultivation of *rickettsia* have been made. Kuczynski has cultivated *Rickettsia prowazeki* in modified blood plasma in celloidin capsules in the abdominal cavity of guinea pigs. The *rickettsia* of the sheep louse is said to grow on a relatively simple glucose blood agar medium. Loewe, Ritter and Baehr, during the past year, have reported upon the cultivation of *rickettsia* from the blood of typhus cases and from the brain and kidneys of guinea pigs, reacting to the blood from typhus fever patients. The media employed consisted in a rich ascitic fluid containing a fragment of sterile rabbit's or guinea pig's kidney and a small amount of two per cent. dextrose bouillon, the tubes being sealed with sterile petrolatum. Wolbach has also just announced the cultivation of *rickettsia* by the living tissue method. Bacot and Segal have shown that injections of lice with a concentrated emulsion of platelets obtained by fractional centrifugalization of the blood of a typhus infected guinea pig affords a sure and quick method of obtaining the development of *Rickettsia prowazeki* in these insects, which suggests under these conditions an association between blood platelets and the *rickettsia* bodies.

Considerable attention has very recently been attracted to the subject of mitochondria. While there is no evidence which would allow us to assume that they are parasitic, there is also as yet no decisive evidence of their significance and nature.

With reference to other cell inclusions recently described, particularly of the red blood cells of vertebrates, Mayer found in rats and in guinea pigs just recovered from a severe trypanosome infection numerous rods, like, but even smaller than, *bartonella,* and dumb-bell forms reminiscent of *rickettsia,* the blood picture being that of a grave anemia similar to that of Oroya fever. These forms he thought might possibly be regarded as degeneration changes or as an outburst of some latent infection. In the latter case, Mayer proposes under reservation the name of *Bartonella muris* for the inclusions. The question then arises whether in certain forms of pernicious anemia where inclusions of a similar nature occur, there may not be present some similar element of infection or excitation of infection.

Attempts to demonstrate microorganisms causing dengue fever have so far been unsuc-

cessful. In 1903 a piroplasma was described as the cause of the disease. This observation has remained unconfirmed. The virus of the disease is believed to be filterable and the disease has been reproduced in man by the inoculation of filtrates of the blood in several cases. *Stegomyia fasciata* and possibly *Culex fatigans* are known to be the transmitting insects. Pappataci fever is also caused by a filterable virus or organism and is transmitted from man to man by *Phlebotomus papatassii*. Since the discovery by Noguchi that yellow fever is caused by *Leptospira icteroides*, which organism will also pass through a Berkefeld filter, it has been suggested that dengue fever and pappataci fever may also be due to a spirochæte, and in fact Couvy has reported that in an epidemic of this disease in Beirut, Syria, which attacked practically the whole population, direct examination of the blood showed the presence of short, slender spirochætes having two or three turns and fine extremities. These were only present when the blood was taken two or three hours before the onset of the fever, never during the course of the pyrexia or after the temperature had fallen. It is not stated whether the organisms were detected by dark-ground illumination or in fresh blood or in stained specimens. Neither has this observation been confirmed during the past year. The methods which led to the discovery of *rickettsia* in the transmitting insect of typhus fever have not yet been applied in connection with either dengue fever or pappataci fever, and no organism has yet been cultivated from the blood by Noguchi's method or on other media.

Trench fever is a disease which resembles dengue fever in a number of ways and yet is obviously quite a distinct infection. It is transmitted in nature by the louse, *Pediculus humanus*. The virus is present in the blood serum of infected individuals during the febrile stage of the disease, and the infection can be transmitted from man to man by the inoculation of such serum. Attempts to filter the virus through Chamberland filters from the blood have been unsuccessful, but under certain conditions it has been filtered from infected urine, and the disease has been reproduced by the inoculation of such filtrates. Certain experiments have been performed which also suggest that the disease may be caused by species of *rickettsia*, in that lice fed on trench fever cases have sometimes developed *rickettsia*, and that lice infected with *rickettsia* have sometimes given rise to trench fever when fed on healthy men. On the other hand lice not showing *rickettsia* have produced trench fever in man and the question has arisen as to whether the virus of typhus has not sometimes been confused with that of trench fever in certain experiments performed with lice. It has been suggested that trench fever is caused by a spirochæte, but it has not been possible to confirm this suggestion. When the cultivation of the *rickettsia* in vitro has been perfected, the inoculation of pure cultures of the species suggested as the cause of trench fever should shed further light upon the problem. It has been demonstrated that the virus of trench fever is very resistant in nature, and if it is of a similar nature to that of typhus fever there would probably be even less difficulty in cultivating it than the typhus virus.

Tsutsugamushi disease or Japanese river fever is an infection which has been proved to be conveyed by a minute red trombidium, *Leptus akamushi* Brumpt. This insect is an ectoparasite of field mice and freely attacks man in the endemic areas of the disease. Recent studies have shown that the virus is present in the blood and that it is not filterable. Nevertheless, it is suggested that it should be classified with the ultra-microscopic disease-producing organisms. Tsutsugamushi has some analogy to both typhus and Rocky Mountain spotted fever, but animals which have received an injection of the tsutsugamushi virus are still susceptible and react to an inoculation of the typhus virus and *vice versa*. The infection is transmissible to monkeys, in which it produces a febrile reaction, enlargement of the lymph nodes and a leucopœnia. The infection is sometimes fatal for the monkey. Guinea pigs are also said to be susceptible, but in these animals the virus produces only a slight temperature and an enlargement of the lymph nodes.

Miyashima has found small elliptical bodies in the larva and adult trombidium which could be cultivated in ascitic agar and when injected into monkeys produced the typical disease. Nagayo and others also found both in human

cases and infected monkeys small organisms, oval or elliptical in shape, with a definite limiting membrane measuring 0.35 to 1 μ. In the endothelial cells of lymph glands their differentiation was difficult.

More recently Hayashi has found minute bodies described as rod, spheroid and ring-shaped in the lymphocytes of lymphnodes and in mononuclear endothelial phagocytes of the spleen and lymph nodes, and in the region of the bite in patients suffering from tsutsugamushi disease. These bodies also occur free in the blood plasma and in severe cases in the red cells. The parasite is said to resemble but show differences from *Bartonella bacilliformis* of Oroya fever and of *Theileria parva* of cattle anemia. For it the tentative name of *Theileria tsutsugamushi* has been proposed. Further confirmation of these observations is extremely desirable.

In more recent work by Kawanura and Yamaguchi no mention is made of the organism described by Hayashi as the causative agent. However, Ishimora and Ogata have found certain coccoid bodies 0.2 μ to 2.15 μ in size in sections made from the lymph glands, spleen and heart of cases of the disease and in the lesions of the testicles of monkeys experimentally infected with blood from human cases. These they were able to repeatedly cultivate in a special ascitic medium and from the cultures to infect monkeys. Megaw in referring to the typhus-like fevers carried by mites in different parts of the world suggests that tsutsugamushi disease is probably related to the sumatra typhus which is transmitted by a tick.

African horse sickness is a disease in which the virus is present in the blood plasma and from which it may be filtered through porcelain filters. It, however, will not pass through collodion sacks or through a layer of one per cent. agar. The virus loses its vitality at 50° C. and it is not destroyed by three per cent. carbolic acid, ten per cent. sodium taurocholate or ten per cent. saponin. A virus mixed with five to ten per cent. solution of lecethin fails to infect but it becomes virulent again when the two are separated. Drying at ordinary temperature destroys it. The virus can be transmitted experimentally by the inoculation of small amounts of the blood. The disease is probably transmitted from animal to animal naturally by the mosquito (*Ochlerotatus*). Ticks can also carry the virus but it has not been demonstrated that the bite of this insect transmits it. *Anopheles* and *Stegomyia* and *Stomoxys calcitrans* have also been shown to transmit the disease at least mechanically. In this connection it may be noted that sometimes the injection of .0001 c.c. of blood into a horse will convey the injection. The disease is not transmitted from animal to animal by contagion, or by feeding, unless the animal is given by the mouth 150 to 200 c.c of blood. Dogs, however, may become infected from eating the meat of infected horses. The disease disappears eight days after frost begins. The virus does not apparently survive in water, although it is fairly resistant. How the infection remains alive for from six to eight months between seasonal outbreaks still remains obscure. Swamp fever or the infectious anemia of horses is probably identical with African horse sickness, but the virus has entirely analogous relations with no other known virus. Whether it undergoes a special life-cycle in the transmitting insect similar to the malarial parasite, for example, is also unknown.

Heart-water disease of cattle, sheep and goats and catarrhal fever of sheep are somewhat analogous diseases, but there is some evidence to show that the viruses causing these diseases are not identical with that of African horse sickness.

Tularæmia has been described recently by Francis as a specific infectious febrile disease due to *Bacterium tularense*, and transmitted from rodents to man by the bite of an infected blood-sucking insect or by handling and dissection of infected rodents. Clinically, the onset of the disease is sudden, with headache, backache, pains in the limbs, lassitude and fever. In cases observed in Utah there was enlargement of the lymph glands which drained the areas surrounding the point of infection and a septic fever lasting from three to six weeks. The site of the insect bite and the adjacent lymph glands became tender and inflamed and they commonly suppurated. The rodents found infected in nature are the California ground squirrel, *Citellus beecheyi*, the ground squirrel of Utah, *Citellus mollis*, the rabbits of southern Indiana and the jack-rabbits of Utah. The insects shown to be capa-

ble of transmitting the infection are *Chrysops discalis, Stomoxys calcitrans, Ceratophylis acutus, Cimex lectularius, Polyplax serratus* and *Hæmodipsus ventricosus*. The first four of these insects bite both rodents and man. Infection probably occurs most commonly through the bite of *Chrysops discalis*. The bacillus causing the disease is a very minute organism and can best be cultivated upon egg-yolk media, but no growth is obtained on ordinary nutrient agar. The organism produces a plague-like disease in rodents, and in fatal guinea pig infections the gross lesions can not be distinguished from those produced by *B. pestis*. The pathological histology of the lesions caused by *B. tularense*, as shown by Councilman and the writer, are, however, quite different. In the lymph-nodes, liver and spleen, there are miliary foci formed by accumulation of mononuclear cells followed by necrosis and infiltration with polymorphonuclear leucocytes. There is a general infection of the endothelium of the blood vessels and the organism may be found in these cells in any part of the body. In addition the organisms pass from the endothelium into the cells of the liver, which they gradually destroy and replace, forming large globular masses of bacilli. The infection of the endothelial cells presents a somewhat similar picture to that seen in typhus fever but not in any other disease where these cells are distended with *rickettsia*.

It is hoped that this article will in some degree serve to emphasize the important position which the subjects of medical zoology, entomology and parasitology have recently taken in connection with general progress in medical science, and the fact that they are subjects which have important practical application in preventive medicine; that they constitute adjuncts to hygiene which have been most successfully prosecuted in tropical countries but which can not be wisely neglected in any country; that by the more thorough and fundamental training of medical men in these branches still greater progress in the elucidation of the many and perplexing problems connected with the etiology, prevention and control of the infectious diseases more common in temperate climates may be expected. Finally, it is hoped that it will not only indicate the most important recent progress in the fields of science referred to, but that it will also serve to some extent to stimulate and guide research in a few of those channels in which further knowledge is urgently needed.

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EXTRACTS FROM ESSAYS OF LEONARDO DA VINCI

LOOKING over the translation of "Leonardo da Vinci's Notebooks" by Edward McCurdy (Scribners), I was reminded of the high praise awarded the great artist-engineer in Lyell's "Principles of Geology." Priests and scholars in da Vinci's day were wrangling over the origin of fossils. Were they forms or models produced in the fatty matter (*materia pinguis*) of the earth by the revolution of the stars? Were they relics of Noah's flood; were they, as Voltaire suggested, cockle-shells; were they dropped from pilgrims' hats during the crusade?

In these notebooks, from which I give here a brief extract, Vinci makes the whole matter perfectly clear, for he was a close observer and a skilful engineer, qualities rare in that age of fine painting and loose thinking. If men had listened, it would not have taken 150 years to prove that fossils had once been alive, and another 150 to prove that they were not all buried simultaneously in the great flood.

DAVID STARR JORDAN
STANFORD UNIVERSITY,
APRIL 6, 1923

Defense of Fossil Shells as Once Living Organisms

As for those who say that the shells are found over a wide area and produced at a distance from the sea by the nature of the locality and the disposition of the heavens which moves and influences the place to such a creation of animal life,—to them it may be answered that, granted such an influence over these animals, they could not happen all in one line, save in the case of those of the same species and age; and not one old and another young, one with an outer covering and another without, one broken and another whole, nor

one filled with sea sand, and the fragments great and small of others inside the whole shells which stand gaping open; nor the claws of crabs without the rest of their bodies; nor with the shells of other species fastened on to them, like animals on the outside where it has eaten its way like a worm in wood; nor would there be found among them bones and teeth of fish which some call arrows, other serpents' tongues; nor would so many parts of different animals be found joined together, unless they had been thrown up there upon the borders of the sea.

And the Flood could not have carried them there, because things which are heavier than water do not float high in the water, and the aforesaid things could not be at such heights unless they had been carried there floating on the waves, and that is impossible on account of their weight.

Where the valleys have never been covered by the salt waters of the sea, there the shells are never found.

Such things are far more ancient than letters, it is not to be wondered at if in our days there exists no record of how the aforesaid seas extended over so many countries; and if moreover such record ever existed, the wars, the conflagrations, the deluges of waters, the changes in speech and habits have destroyed every vestige of the past. But sufficient for us is the testimony of things produced in the salt waters and now found again in the high mountains far from the seas.

Apostrophe to a Huge Fossil Fish, Sword Fish or Tunny

O powerful and once living instrument of constructive nature, thy strength not availing thee, thou must needs abandon thy tranquil life to obey the law which God and time ordained for all procreative nature! To thee availed not the branching, sturdy, dorsal fins wherewith pursuing thy prey thou wert wont to plough thy way, tempestuously tearing open the briny waves with thy breast.

O how many times the frightened shoals of dolphins and big tunny fish were seen to flee before thy insensate fury; and thou, lashing with swift, branching fins and forked tail, didst create in the sea mist and sudden tempest, with loud uproar and foundering of ships; with mighty wave thou didst heap up the open shores with the frightened and terrified fishes, which thus escaping from thee were left high and dry when the sea abandoned them, and became the plenteous and abundant spoil of the neighboring peoples.

* * * * *

O time, swift despoiler of created things! How many kings, how many people hast thou brought low! How many changes of state and circumstances have followed since the wondrous form of this fish died here in this hollow, winding recess? Now destroyed by time patiently thou liest within this narrow space, and with thy bones despoiled and bare are become an armour and support to the mountain which lies above thee.

O how many times hast thou been seen amid the waves of the mighty, swelling ocean, towering like a mountain, conquering and overcoming them! And with black finned back ploughing through the salt waves with proud and stately bearing!

SCIENTIFIC EVENTS

OXFORD MEMORIAL TO SIR WILLIAM OSLER

AT the final meeting of the subscribers to the Oxford Osler Memorial Fund held at the University Museum, Oxford, Sir Herbert Warren, president of Magdalen College, chairman of the executive committee, explained in a brief introduction that the Oxford Memorial was only one of several, the United States of America and Canada, in which Sir William had spent a larger part of his life, having decided to establish memorials of their own.

The secretary, Dr. J. A. Gunn, stated that the fund now amounted to just short of £2,000. The following proposals were submitted on behalf of the executive committee:

(1) The purchase of a bronze plaque of Sir William Osler, measuring 32 by 22 inches, a copy of that by Vernon of Paris, made for the Medical Faculty of Maryland, to be hung in the university museum; (2) the establishment of a fund for the foundation of an Osler Memorial Medal in bronze, to be awarded every five years to a graduate of the University of Oxford who has made some distinguished contribution to medical science, learn-

ing or practice. This medal might be a reduced replica of the portrait plaque; (3) the remainder of the sum, together with any sums hereinafter added, to be called the "Osler Traveling Fund," for the propagation or acquisition of medical knowledge or for medical research, to be invested and the interest utilized to assist teachers of the medical faculty to travel for the purposes stated. It is estimated that the capital sum remaining for this purpose will be about £1,700.

Sir Archibald Garrod, regius professor of medicine, in introducing these proposals, stated that they had the entire approval of Lady Osler, as well as of other friends from whom letters had been received. They were supported by Surgeon-Major-General Sir Frederick Bradshaw and adopted *nem. con.* and the executive committee, which consists of Sir Herbert Warren, Sir Archibald Garrod, Sir Charles Sherrington, Professor Arthur Thomson, Mr. A. P. Dodds Parker, honorable treasurer, and Professor J. A. Gunn, honorable secretary, were empowered to take steps to carry them into effect, and, in particular, to negotiate any arrangements with the university which may be found desirable.

THE COMMITTEE OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE ON PHOTOSYNTHESIS

THE Committee of the American Association for the Advancement of Science on Photosynthesis which was authorized at the Boston meeting following the notable symposium on this subject has recently completed its organization by the acceptance of the following persons as members:

Dr. C. G. Abbot, assistant secretary Smithsonian Institution.

Dr. F. G. Cottrell, director Fixed Nitrogen, Research Laboratory, Washington.

Dr. Moses Gomberg, Department of Chemistry, University of Michigan.

Dr. W. J. Humphreys, meteorological physicist, United States Weather Bureau, Washington, D. C.

Dr. D. T. MacDougal, director Department of Botanical Research, Carnegie Institution of Washington, *chairman*.

Dr. S. E. Sheppard, in charge of Department of Physical Chemistry, Research Laboratory, Eastman Kodak Company, *secretary*, Rochester, N. Y.

Dr. E. E. Slosson, director of Science Service, Washington.

Dr. H. A. Spoehr, member, Department Botanical Research, Carnegie Institution of Washington.

The preliminary activities of the committee will be directed chiefly to bringing together information as to current researches being carried on in various laboratories, and to serve as a focus of interest in the subject. Arrangements are being made for some special lectures on the subject. Attention will be given to the matter of obtaining funds and facilities in the furtherance of research on various phases of the subject.

EXPEDITION TO THE HAWAIIAN ISLANDS

THE Bureau of Biological Survey of the United States Department of Agriculture, in cooperation with the Bishop Museum of Honolulu, began on April 4 a comprehensive scientific survey of the islands of the Hawaiian archipelago, from Niihau to Midway and Wake.

The objects of this expedition are two fold: first, to make a much needed survey of the Hawaiian Island bird reservations to ascertain the situation as to the bird life of these great breeding places for sea-fowl, and, second, to take advantage of the opportunity to make a comprehensive scientific survey of the islands visited. This last will make a contribution to the general survey of the islands of the Pacific, now being promoted by the Bishop Museum. The National Research Council, in furtherance of its policy to promote the investigation of the resources of the Pacific, has made a grant of funds to assist the expedition.

Dr. Alexander Wetmore, of the Bureau of Biological Survey, is in charge of the expedition, and took with him as field assistant Charles E. Reno, of the same bureau. The expedition, in addition, is made up of a corps of scientists from the Bishop Museum, led by the director, Dr. Herbert E. Gregory. These include S. C. Ball, curator of biology; D. T. Fullaway, entomologist; E. L. Caum, botanist; D. Thaanum, conchologist; C. Grant, general assistant, and J. W. Thompson, preparator. Mr. Donald R. Dickey, of Pasadena, California, accompanies the expedition as photographer, to secure motion pictures of the noteworthy colonies of sea birds found on Laysan Island.

One object of the expedition is to exterminate the rabbits on Laysan, where at least two European species introduced by a guano company have increased to such an extent as to endanger the continued existence of the vegetation, and indirectly, that of several species of birds inhabiting the reservation.

Through the courtesy and interest of Secretary Denby and Assistant Secretary Roosevelt, of the Navy Department, a vessel has been placed at the disposal of this party for a period of four months. Plans have been made for this boat to return once a month to Honolulu in order that the work of the expedition may be more effectively accomplished and to enable a number of scientists to participate who otherwise could not do so.

E. W. NELSON
Chief, Biological Survey

APRIL 26, 1923

THE INDIANA ACADEMY OF SCIENCE

THE Indiana Academy of Science will hold its spring meeting and field excursion at Brookville, Indiana, on May 10, 11 and 12, 1923. This meeting is somewhat of the nature of a tribute to Dr. Amos W. Butler, one of the founders of the academy. Dr. Butler has just resigned his position as secretary of the Indiana State Board of Charities after twenty-five years of distinguished service. In 1881 he organized the Brookville Natural History Society and four years later, largely through his suggestion and efforts, this society was transformed into the Indiana Academy of Science. Dr. David Starr Jordan was the first president of the academy and on May 20, 1886, the first field meeting was held at Brookville. That night at a public meeting Dr. Jordan delivered an address on "Charles Darwin."

The program includes a public meeting to which citizens of Brookville are invited. Brief addresses will be delivered, as follows:

(1) Brookville and its contribution to the intellectual life of the state: John C. Shirk.

(2) The geologic aspects of Brookville and vicinity: D. R. Moore.

(3) Changes in Indiana flora: Stanley Coulter.

(4) Some reminiscences of early academy days: Amos W. Butler.

A day will be spent in a field excursion to various points along the Whitewater River, or one of its tributaries. This section of the country is one of the most picturesque in Indiana. The town of Brookville is located at the junction of two branches of the Whitewater and flanked by lofty hills. There will be ample opportunity to study the natural history of the region and to discuss them at the informal meetings.

Scientists from neighboring states are invited to attend this meeting.

HARRY F. DIETZ
Press Secretary

AMERICAN SCHOOL IN FRANCE FOR PREHISTORIC STUDIES

IN entering upon the third year of its activities, the school invites the affiliation of capable graduate students of either sex who may wish to avail themselves of the opportunities that are offered.

The object of the school is to give the American student of man's antiquity and evolution and old world archeology sound first-hand knowledge in these lines under capable and experienced leadership.

The two first years of the school were devoted principally to instruction in the museums of France and to careful excavations on one of the sites of early man in that country, namely, La Quina. The work of the third year will differ in a measure. Its object will be first to acquaint the students directly with all the important sites and remains of early man in western Europe, and to engage in actual excavations only after the students have received a good foundation in the subject.

The work will commence on July 1 in London, and it will comprise on the one hand the study of the original specimens relating to early man in the various museums of England, France, Belgium, Germany, Czechoslovakia, Croatia, Austria and Switzerland, and on the other, visits to such important sites as the Piltdown, La Quina, Dordogne, Mauer, Ehringsdorf, Brno, Krapina and others as far as time will permit. Following this a site in France will be chosen where careful methods of excavation may be taught and practised; and when field-work becomes impossible the students desirous of staying abroad will be

helped to opportunities for further studies. The months of July and August, with probably a part of September, will be spent in visits to the various sites and museums; the rest of September and October will be devoted to field work in France; and for the winter months arrangements will be made in Paris or elsewhere according to the best interests of the students.

The conditions of affiliation with the school on the part of the students are good health and character, proper introduction, serious purpose and a spirit of earnest cooperation with the director. The students may be accepted for three, six, nine or twelve months. They pay nothing to the school or for field work, but defray all their personal expenses. To reduce the latter and facilitate matters in general, the students will elect among themselves a committee which will see to transportation, accommodation and other things concerning the whole group. Upon the completion of their course, deserving students will be given a suitable certificate by the school.

Applications should be sent to the director before May 30 at the latest. The participants will need to make steamship reservations well in advance and allow plenty of time for obtaining their passports and visés.

ALEŠ HRDLIČKA
Director, 1923-24
U. S. NATIONAL MUSEUM,
WASHINGTON, D. C.

SCIENTIFIC NOTES AND NEWS

AT the meeting of the National Academy of Sciences held in Washington on April 25 Dr. A. A. Michelson, professor of physics in the University of Chicago, was elected president in succession to Dr. Charles D. Walcott, secretary of the Smithsonian Institution. Dr. J. C. Merriam, president of the Carnegie Institution of Washington, was elected vice-president in succession to Dr. Michelson. Dr. David White, of the United States Geological Survey, was elected secretary to succeed Dr. C. G. Abbot, assistant secretary of the Smithsonian Institution and director of the Astrophysical Observatory. Professor R. A. Millikan, of the California Institute of Technology, continues as foreign secretary and Dr. F. L. Ransome, as treasurer.

THE following men of science have been elected to membership in the National Academy of Sciences: Solon Irving Bailey, Harvard Observatory; James Henry Breasted, University of Chicago; Ernest William Brown, Yale University; Carl H. Eigenmann, University of Indiana; Yandell Henderson, Yale University; Marshall Avery Howe, New York Botanical Garden; Max Mason, University of Wisconsin; Elmer Drew Merrill, Bureau of Science, Manila; Eugene Lindsay Opie, Washington University, St. Louis; Leonhard Stejneger, United States National Museum; George Fillmore Swain, Harvard University; Richard Chace Tolman, California Institute of Technology; David Locke Webster, Stanford University; Frederick Eugene Wright, Geophysical Laboratory of the Carnegie Institution; Robert Mearns Yerkes, National Research Council.

AT the meeting of the American Philosophical Society on April 21, the following were elected to membership: Frank Aydelotte, Swarthmore; Edward Asahel Birge, Madison; Isaiah Bowman, New York; Carl Darling Buck, Chicago; Karl E. Compton, Princeton; Herbert Ernest Gregory, New Haven; Charles Downer Hazen, New York; Phoebus A. Levene, New York; George Perkins Merrill, Washington; Samuel Alfred Mitchell, Charlottesville; Richard Bishop Moore, Washington; William John Sinclair, Princeton; Vilhjálmur Stefánsson, New York; Rodney H. True, Philadelphia; Thomas Wayland Vaughan, Washington.

A CITATION for the award of a distinguished service medal to Dr. Harvey Cushing of Boston has been approved by Secretary of War Weeks. The citation refers to Dr. Cushing as senior consultant of surgery of the American Expeditionary Forces and in direct charge of treatment of gunshot wounds of the First Army Hospital during the Meuse-Argonne offensive and says: "He performed conspicuous and distinguished services to the government" and "his individual efforts in that capacity saved the lives of many severely wounded soldiers."

AWARDS of the Royal Geographical Society have been made as follows: The Founder's Medal to Mr. Knud Rasmussen for his exploration and research in the Arctic regions during the last twenty-five years. The Patron's Medal to the Hon. Miles Staniforth Cater

Smith, for his explorations in the unknown interior of Papua. The Murchison Grant to Captain A. G. Stigand, for his map of Ngamiland. The Back Grant to Mr. B. Glanvill Corney, for his studies in the historical geography of the Pacific. The Cuthbert Peek Grant to Messrs. R. A. Frazer and N. E. Odell, to assist them in continuing their explorations of Spitsbergen. The Gill Memorial to Captain Augiéros for his journey in 1920-1921 from Algiers to Mauritania.

THE Hansen prize for distinguished microbiological work has been awarded this year by the committee of Danish trustees to Dr. E. J. Allen, director of the Marine Biological Association's laboratory at Plymouth.

DR. HUGH M. SMITH, formerly commissioner of fisheries, has been appointed fisheries adviser of the Siamese government. Dr. Smith is sailing for Bangkok by way of San Francisco and Honolulu.

N. H. DARTON has returned to his office in the United States Geological Survey after an absence of nearly two years completing the field work on the geologic map of Arizona. The University of Arizona recently conferred on Mr. Darton the honorary degree of doctor of science in "recognition of his investigations on the geology of the Southwest."

THE first award of the Mary Ellis Bell Prize for the best undergraduate work in medical research at the University of Pennsylvania was made to Messrs. J. B. Barnwell and R. Lynch for their work on transplantation of islet tissue. This work was presented at the fifteenth annual meeting of the Undergraduate Medical Association on April 19.

PROFESSOR T. H. PARDO DE TAVERA, of the University of the Philippines, has been appointed director of the Philippine library and museum.

DR. VICTOR F. HESS, chief physicist of the United States Radium Corporation, has resigned in order to return to the University of Graz, where he holds the chair of experimental physics.

PROFESSOR GEORGE C. WHIPPLE, of Harvard University, has resigned from the Public Health Council of the Massachusetts State Department of Public Health in order that he may have more time for his teaching and for his private practice. Professor Whipple was recently elected president of the Anti-mosquito Association of Massachusetts.

PROFESSOR SUTHERLAND SIMPSON, of the Ithaca Branch of the Cornell University Medical College, will leave late in May to attend the eleventh international physiological congress at Edinburgh and will spend the rest of his sabbatic leave in Denmark, Holland, France and Belgium, returning to Ithaca for the second term of the next academic year.

DR. WALTER W. KING, surgeon, United States Public Health Service, Washington, has been directed to proceed to Hull, England, to attend the Congress of the Royal Sanitary Institute, beginning on July 30.

SIR HAROLD JALLAND STILES, professor of surgery at the University of Edinburgh and former president of the Association of Surgeons of Great Britain and Ireland, occupied the chair of Dr. Harvey Cushing of Harvard University, Boston, for one week during April; he then spent a week at the Johns Hopkins University, Baltimore.

THE *Journal* of the American Medical Association writes: "In 1919, the American Association of Pathologists and Bacteriologists presented to Dr. Harold C. Ernst, Boston, a gold headed cane, a token of appreciation of his services to the association and to medicine. Before his death, in 1922, Dr. Ernst conceived the idea of using the cane as a sign of approval of the work of those who represent the best traditions in medicine. The council of the association will, therefore, confer custodianship of this token from time to time, such custodianship to last throughout the recipient's lifetime. It was unanimously voted this year to confer the custody of the cane on Dr. William H. Welch, of Baltimore, who has accepted the honor. Dr. Welch will prepare a manuscript on his experiences in medicine, to maintain the historical significance of the cane."

THE formal opening of the laboratories of the Philadelphia Research Institute of Cutaneous Medicine was held on April 26, with Dr. David Riesman presiding. Dr. Udo J. Wile, of the University of Michigan, gave the opening

address. Dr. Jay Frank Schamberg is director of the institute.

DR. OTTO MEYERHOF, professor of physiology in the University of Kiel, as a guest of the department of physiology of Washington University School of Medicine, lectured on the "Dynamics of muscles" and the "Energetics of cell processes" on April 17 and 18.

PROFESSOR HERMAN L. FAIRCHILD, emeritus professor of geology in the University of Rochester, was the speaker at the weekly luncheon of the Cornell Club of Rochester on March 14. His subject was "The conservation of the water supply in New York state."

ON March 29 to 31, Dr. T. Wayland Vaughan, of the United States Geological Survey, gave a series of five lectures on the origin of limestone and coral, coral reefs and coral reef regions before the faculty and advanced students of the department of geology of the University of Wisconsin.

THE May lecture of the Institute of Metals for the present year was delivered by Dr. W. Rosenhain on May 2. The subject was "The inner structure of alloys."

A MEETING was held at Columbia University on April 24 to commemorate the four hundred and fiftieth anniversary of the birth of Copernicus. Addresses were delivered by President Nicholas Murray Butler, Dr. Henry S. Pritchett, president of the Carnegie Foundation for the Advancement of Teaching, and Ladislas Wroblewski, Polish minister to the United States.

THE Paris correspondent of the *Journal* of the American Medical Association writes: "The government, desirous of encouraging all movements connected with the commemoration of Pasteur and deeming it advantageous to offer all the elements of the population an opportunity to participate, has authorized a tag day in honor of Pasteur. It will not be the sole purpose of this manifestation to exalt the memory of one of the most eminent French scientists. Of equal importance will be the endeavor to awaken public opinion in support of a widespread movement in favor of the development of scientific laboratories and the improvement of the various material resources placed at the disposal of our men of science for the carrying out of their researches. A circular letter expressing this idea has been sent to the prefects by the minister of the interior. May 27 has been chosen for the tag day. The proceeds will be used for the benefit of scientific laboratories."

MR. EDMUND F. DICKINS, hydrographic and geodetic engineer in the United States Coast and Geodetic Survey since 1869, died at San Francisco, California, March 2, in the seventy-ninth year of his age, after a service of fifty-one years. He had been retired from active duty since 1920. He was director of coast surveys in the Philippine Islands from 1908 to 1911 and had held many other important assignments.

DR. JOHN VENN, president of Caius College, Cambridge, distinguished for his work on logic and later for his archeological researches, died on April 4, in his eighty-ninth year.

DR. CHARLES EMMANUEL FORSYTH MAJOR, F. R. S., known for his work in paleontology, died on March 25, aged seventy-nine years.

ERNEST WATSON VREDENBURG, known for his work on the paleontology of India, died on March 12, aged fifty-three years.

A CORRESPONDENT writes: News has been received of the death on April 11, at Cringleford, Norwich, of Frederick William Harmer, father of the director of the British Museum (Natural History), in his eighty-eighth year. A fellow of the Geological Society and long interested in the Pliocene of Britain, he was active until the very last, completing just before his death the last plate of his important "Monograph of the British pliocene mollusca" which has been in process of publication since 1914 by the Paleontographical Society. This work for future students will take the place long occupied by the classical monograph of the Crag Mollusca, by Searles Wood, and constitutes a permanent memorial of its venerable author.

THE meeting of the French Association for the Advancement of Science will be held this summer at Bordeaux.

THE department of geology, United States National Museum, has received as a gift from Dr. Frank Springer the paleontological collec-

tions of the late Orestes H. St. John. The collection contains a large and valuable series of Selachian fishes including many type specimens, the most notable of these being a specimen from the coal measures of Kansas, containing the complete dentition of a large shark of paleozoic time.

DR. BRUNO GALLI VALERIO, professor at the Lausanne University, proposes to erect a meteorological observatory and a scientific research station on the top of the Rochers de Naye (6,473 ft.) above Montreux.

PRESIDENT MARION L. BURTON, of the University of Michigan, has received a letter from Carl Guthe, who is conducting an archeological expedition of Michigan men in the Philippines, in which the writer tells of the success of the expedition. More than 100 caves have been uncovered by the excavators in which were discovered many ancient implements and other remnants of an extinct civilization. The party is carrying on the expedition through the generosity of a Detroit alumnus, who provided anonymously $30,000 for the expenses of the expedition.

THE London *Times* reports that a number of German professors and officials have issued Easter appeals for monetary assistance on behalf of their various institutes. Professor Einstein, who appeals on behalf of the Kaiser Wilhelm Institute for Physics, states that the income of the institute before the war was 75,000 marks (then worth £3,750). It is now about 22,000,000 marks, which is worth about £225. Appeals are made also for the Cancer Research Institute, the Botanical Gardens and other institutions.

HIRAM PERCY MAXIM, president of the American Radio Relay League, will confer with Donald B. MacMillan, polar explorer, to make arrangements to send an amateur radio operator of the league to the polar regions on MacMillan's expedition next June. It will be the first time that a polar expedition will be in regular communication with the amateur radio operators of the country. The operator will be selected from 12,000 league members by questionnaires, which are being sent to amateur operators in all parts of the United States. Mr. MacMillan will make the selection.

UNIVERSITY AND EDUCATIONAL NOTES

THE $2,000,000 endowment fund for the Henry Phipps Psychiatric Clinic at the Johns Hopkins University has been completed.

PLANS have been completed for the establishing of a $500,000 maternity hospital with the Washington University School of Medicine group. This hospital will be an eight story building and will eventually have a two hundred and fifty bed capacity instead of the thirty-three bed capacity of the present St. Louis Maternity Hospital, which it will succeed. It will have a similar affiliation with the medical school as the St. Louis Children's, the Shriners' Hospital for Crippled Children and the Barnes Hospital now hold. Ground will be broken within the next six months.

GOVERNOR SMITH has vetoed the appropriation of $830,000 for a new plant industry building for the New York College of Agriculture at Cornell University with the explanation that a special bill would later carry a larger sum, in accordance with new estimates made by the state architect.

WITHROW MORSE, Ph.D. (Columbia) has been elected to the chair of physiological chemistry and toxicology in the Jefferson Medical College, Philadelphia. Dr. Morse is at present professor of physiological chemistry in the school of medicine of the West Virginia University.

PRESIDENT WALLACE W. ATWOOD announces a number of additions to the faculty of Clark University, including, for one year, Dr. J. F. Neirmeyer, rector of the University of Utrecht, Holland, economic geography; Dr. Oliver Edwin Baker of the United States Department of Agriculture, professor of agricultural geography; Dr. Alfred L. P. Dennis, professor of modern history; Clarence Fielden Jones, M.S., assistant professor of economic geography; Ellen Church Temple, acting professor of anthropo-geography; William L. Langer, assistant professor of European history; Douglas C. Ridgeley, professor lecturer in geography.

THE resignations from Clark University are announced of Dr. Harry E. Barnes, professor of the history of thought and culture, and Rob-

ert C. Dexter, professor of social science. Dr. Barnes has accepted a position in the sociological department at Smith College. Mr. Dexter will become head of the department of sociology at Skidmore College.

DR. FREDERICK G. BANTING, Toronto, will be appointed to a chair in medicine at the University of Toronto if plans of the university and the provincial government materialize. An annual allowance of $10,000 accompanies the appointment, $6,000 being for salary and the remainder for supplies, assistants and other expenses.

DISCUSSION AND CORRESPONDENCE

CONCENTRATIONS OF IONS OF INSOLUBLE OR UNDISSOCIATED SALTS IN SOLUTION

PROFESSOR RODEBUSH in his recent comment[1] on a note by the writer on the mode of reaction of slightly soluble salts[2] has pointed out the improbability of the existence of a statistical equilibrium in a solution with only one ion or even less per liter. Since, as a result of the work of Gibbs and Boltzmann, entropy and thermodynamic equilibrium are considered to be statistical phenomena, it follows that when a statistical equilibrium is improbable, a thermodynamic equilibrium is likewise so. As a matter of fact, the concentrations of cathions of insoluble sulphides or complex ions obtained by calculation from E. M. F. measurements are of such a magnitude as to exclude thermodynamic equilibrium which is the fundamental assumption underlying such a calculation.

It is very questionable whether Knox's[3] calculations of the solubilities of the sulphides based on E. M. F. measurements should be taken literally. That these calculations are not always valid may be seen from the fact that while Knox gives a value of 2.6×10^{-15} for the solubility product of PbS, Noyes and Bray[4] find by precipitation methods a value of at least 1.8×10^{-22} and Stieglitz[5] believes that 2×10^{-27} is not low enough.

1 SCIENCE, N. S., lvii, 358, 1923.

2 *Ibid*, lvii, 26, 1923.

3 *Trans. Faraday Soc.*, iv, 44, 1900.

4 *J. Amer. Chem. Soc.*, xxix, 137, 1907.

5 Qual. Chem. Analysis, Vol. I, p. 212, 1916 edition.

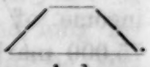
One of two possibilities suggests itself: either there is a sufficient concentration of ions in the solutions of the insoluble substances to make possible a thermodynamic equilibrium and that the resulting E. M. F. is not indicative of the actual ionic concentration, but rather of the effectiveness of the concentration present as compared to that of a solution containing one mole of ions per liter; or there is no thermodynamic equilibrium and the E. M. F. is not the result of an equilibrium between the electrode and the particular ions in solution. From the agreement in the degree of insolubility of the series of sulphides as found by E. M. F. measurements and by precipitation methods, it would seem that we may assume the first alternative to be the correct one and as another instance of the unreliability of calculations from such measurements at low concentrations.

BENJAMIN S. NEUHAUSEN
JOHNS HOPKINS MEDICAL SCHOOL

AN EGYPTIAN MATHEMATICAL PAPYRUS IN MOSCOW

IN an article[1] which appeared in 1917, Mr. B. Touraeff gives an account of a mathematical papyrus of the late middle empire, now in the Museum of Fine Arts in Moscow.

The translation of probably the most important new problem, giving the volume of a truncated pyramid, is as follows:

"The problem is to make a  . If it be said: ' . . . 4 below, 2 above,' do as follows: square this 4, which gives 16; duplicate 4, which gives 8. Do as follows: square the 2, which gives 4. Add the 16 to the 8 and the 4, which gives 28. Do as follows: take one third of 6, which gives 2. Do as follows: take 28 twice, which gives 56. This is the 56. You will find it correct."

This is precisely following the formula which we would use to calculate the volume of a truncated square pyramid with upper base 4 on a side, with lower base 2 on a side, and with altitude 6.

The remarkable appearance of this formula

1 "The volume of the truncated pyramid in Egyptian mathematics," Ancient Egypt, 1917, pp. 100-102.

is paralleled by the use of somewhat analogous formulas in finding the sum of a geometric series and in solving problems in arithmetical series in the Ahmes papyrus[2] which antedates by one hundred or more years the recently famous King Tut-ankh-amen.

Another problem in the Moscow papyrus is concerned with determining the "sides of a quadrilateral, when the relation of the sides and the area of the quadrilateral are known." This problem is almost equally important, as it indicates clearly the Egyptian inspiration of a whole series of problems found in Euclid's Data. The problems in question are concerned with the determination of the sides of a rectangle when the area and some other relationship of the sides are given.[3]

LOUIS C. KARPINSKI
UNIVERSITY OF MICHIGAN

ZIRCONIUM FRACTIONS

A COMMUNICATION by Professor Kurt A. Grönvall in *Svensk Kem. Tids.* for April may be of interest to some of your readers. Professor Grönvall has been reading some back numbers of his *Zeit. für Kristallographie* and came across references to zirconium fractions which led their observers to all the thrills of discoverers of new elements. These supposedly new elements were observed before Nils Bohr came upon the scene with a new fangled tool and could not therefore be clinched as was hafnium. The elements from zirconium are: ostranium discovered by Breithaupt of Freiburg in 1825, noranium by Svanberg of Uppsala, discovered in 1845, and jargonium by the first petrographer, H. C. Sorby, from zirconium collected in Ceylon, 1869. Now comes hafnium with its several discoverers. Professor Grönvall asks us, "Is hafnium a new element?"

ANTON R. ROSE
EDGEWATER, N. J.
APRIL 22, 1923

[2] Karpinski, "Algebraical developments among the Egyptians and Babylonians," *Amer. Math. Mo.*, Vol. 24, 1917, pp. 257-265.

[3] Problems 85-90 in Simson's edition of Euclid's Data; in Opera Omnia ed. Heiberg and Menge, Vol. 6, Prop. 84-86, pp. 165-173.

QUOTATIONS

FEDERATIONS OF SCIENTIFIC MEN

THE reluctance to discuss the monetary value of their services is a tradition which dies hard among the brain-workers in this country and abroad, and is in large measure responsible for the unenviable position of many salaried workers during and since the war. In the legal and medical professions, which occupy a legalized privileged position and are further safeguarded by the needs and the attitude of the community, professional unity is possible and demands for improved conditions of service and better remuneration for these classes are generally successful. The success of medical men in this country in particular has given an impetus to other professional workers towards combination, and various organizations now exist having for their avowed object the improvement of the economic position of the professional classes. In France, after approaching first the Confédération Générale du Travail, and later the General Association of Employees—both organizations of manual workers—the brain-workers have decided to form their own independent Confédération des Travailleurs Intellectuels. It is already in a position to exert considerable influence in the chamber of deputies and the senate, and its success has provoked the creation of similar bodies in several other European countries. In this country there is an organization, the National Federation of Professional, Technical, Administrative and Supervisory Workers, founded in 1920, having similar aims. Hitherto it has not been able to obtain the support of the medical, legal, engineering, teaching or scientific associations. These may join the federation later, but, in the first instance, they will probably find it better to form their own federation. The time is certainly opportune for a movement to be made in this direction.—*Nature*.

THE INTERNATIONAL WORK OF SCIENTIFIC SYNTHESIS[1]

THE current development of science is so varied and so extensive that even the expert is

[1] A review of the international journal, *Scientia*.

finding difficulty in keeping in touch with the detailed acquisitions not merely in his own field but often also in those divisions of it to which his own labors are devoted. This has become so pronounced that one sometimes hears the fear expressed that the body of science is in danger of falling apart into chaos from its mere bigness and diversity. It is often true that experts in the same field can not understand the details of each other's work well enough to judge its value with any confidence; and the different sciences have adopted each a jargon peculiar to itself so that workers from different fields find that they speak so little the same language that they can sometimes scarcely understand each other at all.

And yet there is a deep-seated conviction that all valid sciences must be parts of one whole, one Science, which subsumes all of them under its universal extent. If such a general science exists effectively, in the sense of a body of truth which is accessible to all intellectually minded people with a desire to understand it, it must be possible to gather the essentials of this science into an organized whole whose connections are not very complicated. This science must be organized along rather simple lines and its main truths must be capable of being brought into connection under a few general headings of a comprehensive character.

To accomplish this synthesizing of exact truth requires a great international work of scientific synthesis—a work in which different peoples and different sciences are brought together in a large constructive effort. It is not desirable, and it would be impossible, to bring the necessary group of people together in a definite organization and to carry out this work by means of a concentrated effort under the direction and inspiration of a central organization. This is not the way in which the task is to be accomplished. What is needed for the purpose in mind is a world's arena for the highest philosophic and scientific analysis and discussion among the greatest living thinkers, among those who are now advancing the separate sciences and at the same time are looking for those connections which bind all science into a great and fundamental unity.

A unique journal for serving these purposes now exists in *Scientia*, an international review of scientific synthesis published at Milan, Italy.[2] This journal has an interesting feature which makes all of its articles accessible to those who read the French language. If an author writes for it in a language other than French his article is published both in its original language and in a French translation. This journal serves as a great international encyclopedia of current philosophic synthesis of scientific truth. It is doing a great international work which would be left undone if it did not render this service. It is much more than a storehouse for such articles as are submitted to it. It organizes the preparation of important series of papers by the experts of all countries, the papers in a particular series all dealing with the various aspects of some important subject.

At the present time, for instance, a series of articles on relativity is being prepared by experts from all over the world; and these will be published in due course. Each writer, even on this difficult and abstruse subject, is required to express himself in the language which is current among educated men and women everywhere. He is denied the use of the technical language which the experts employ in communication with each other. That technical language has its use. But what is expressed in it is inaccessible to those who are not experts. What *Scientia* demands is the exposition of the important ideas of relativity in a language which is free from technical expressions so that the articles may be accessible to thinkers in every field of thought. A similar demand is made with respect to all the articles which are to be published in *Scientia*. The editors can hardly claim that they have succeeded in holding every contributor to the ideal which they have set; but their success has been sufficiently great to make of *Scientia* a forum for the philosophic discussion of scientific questions in such a form as to elicit the interest of all people who believe in the broad philosophic synthesis of science.

A great purpose has inspired both those who

[2] *Scientia*, edited by Eugenio Rignano and published at Via A. Bertani, 14, Milan, Italy. American subscribers can conveniently purchase it through Messrs. Williams & Wilkins, Mount Royal and Guilford Avenues, Baltimore, Maryland, at ten dollars per year (twelve issues).

initiated the publication of *Scientia* and those who have continued its work. They have desired to place at the disposal of every cultivated person an instrument of scientific synthesis which might facilitate that work of coordination and systematization of knowledge rendered necessary by the growing need of rapid summaries and careful accounts of central ideas suitable to enable one quickly to orient himself with respect to the most vital scientific ideas of the day. In serving this purpose the editors have realized that it is necessary to give rigorously exact information concerning new researches and the hypotheses which are elaborated or proposed by various workers for extending the bounds of human knowledge; and they have spared no pains to procure accounts of these by the experts best fitted to give them—accounts which move not in technical terms but in the language of all cultivated people. The new ideas and discoveries are thus being rendered accessible to all persons, with the hope that science may live more as a unit both among scientific workers generally and also in the minds of all cultivated persons who are interested in the work of science. *Scientia* is seeking to bring the great guiding ideas of science out of the scientific preserves of individuals and of small groups and to help make it possible for all to enjoy the intellectual advantages of scientific thought and discovery. If the world of thought tends to become little to any one through an over-emphasis of his specialty, *Scientia* is effectively urging him to come out into a broader field of scientific thought. Let him still pursue his narrow specialty with all vigor and ardor, if he will; but let him at the same time see it as a small part of a fascinating whole and let him understand that the connections of his specialty with this whole are more important in their human values than the details of his work are in themselves.

Through the pages of this unique journal the leading thinkers of Europe and America are contributing towards a realization of this inspiring ideal. Independence of judgment, clearness of form, absence of all prejudice, liberty of criticism characterize their contributions. The continued success of this effective organ of international culture is a matter of importance to the development and unification of science. It aims at reaching a systematic and synthetic order of truth suitable to give a general view of the physical and human world within the limits of the most rigorous scientific knowledge. In carrying out this plan it has organized cooperation in the preparation of articles on the causes of the great war, on the international questions growing out of it, on social questions, on the problem of vitalism and mechanism in biology, on the now famous theory of relativity, on the contributions of the various peoples to the development of the several branches of human knowledge, and on other questions of deep interest in the current thought of the world.

By these means *Scientia* has become suitable to serve as a valuable instrument for the cultural development of all those who love knowledge. Specialists may find in it an incentive to look beyond their own gardens of thought, to enlarge their intellectual horizons and to increase their joy in truth. People of culture have through it a unique opportunity to become acquainted with many trends of current thought and to obtain a panoramic view of the intellectual world. Perhaps there is no other single journal in the world which so effectively brings to its readers a knowledge of the present currents in the intellectual life of mankind. Now in its seventeenth year, *Scientia* seems to have received a new impulse from the novelty and importance of the problems which have been pressing upon men in the recent eventful years. It is achieving with increased success its object of reacting against the excesses of specialism and of breaking down the partitions which have separated one from another the diverse branches of science and those who cultivate them.

Such is the work for which *Scientia* stands and such is the ideal which it holds up before all scientific workers.

This ideal, as supported by *Scientia* and various other agencies throughout the world as well as by a considerable number of individual thinkers, may yet inspire a greater work than any which can be accomplished by the more or less fragmentary articles of a periodical. It will do much to furnish the material to some great thinker who will give his life to a fresh synthesis of truth and it will hold up his hands in the arduous undertaking. The materials for such a comprehensive synthesis should be gath-

ered and put into order in such a form that an original thinker who would encompass all of them would find it possible to do so in a lifetime and still have left that energy which is necessary to fuse and unite the whole material in the fire of his intellect and mould it into a great (even though tentative) synthesis of scientific truth.

Such a work can not be done once for all. Science continues to grow and novel thoughts arise occasionally in its progress. These will ever require new syntheses if they are to be comprehended properly. No such work of philosophic interpretation can ever be final, for science itself can never reach a final and completed stage. Each generation or century will need to do it again; but this lack of finality does not make the work of any the less importance.

It is important that the great scientific ideas of each generation should come out of their technical dress and be set forth in a literary form which makes them pleasingly accessible to all cultivated persons with a tendency to philosophic interpretation. To this double work of the synthesis of truth and the putting of it into an accessible form the editors of *Scientia* have committed that journal, and it is going forward with increasing success towards the realization of this high aim.

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SPECIAL ARTICLES

PARAMAGNETISM AND THE THEORY OF QUANTA

THE last issue of the *Journal de Physique* contains an interesting and meritorious review by B. Cabrera of the extensive work done by different observers on the magnetism of salts of metals of the iron group. A conspicuous part of this work is due to Professor Cabrera himself and to his pupils and was heretofore outside the reach of most of the scientific readers, because it was published in Spanish journals.

I wish to draw the attention of the physicists engaged in magnetic research to an interpretation of which the material presented by Professor Cabrera is susceptible, and which seems to me to be a strong support of the quantum theory of magnetism. It is well known that the theory of electrons gives a simple relation between the magnetic moment of an atom m and its chief moment of momentum G

$$(1) \qquad m = \frac{e}{2\mu} G$$

e/μ being the ratio of the charge of an electron to its mass. On the other hand, the theory of quanta admits only certain discreet values of the moment of momentum G, *to wit*, whole multiples of the value $h/2\pi$, where h denotes Planck's universal constant of action. The result is that the magnetic moment of an atom (or ion) is also a whole multiple of an elementary value

$$m_0 = \frac{eh}{4\pi\mu}$$

so that

$$(2) \qquad m = j\, m_0$$

where m_0 is called the "Bohr-Magneton" and the integer j (in *Sommerfeld's* terminology) the "internal quantic number" of the atom.

The conception that the atomic magnetic moment is a multiple of a "magneton" was originally introduced empirically by *P. Weiss*. However, the empirical "Weiss-Magneton"

Ion	m in W.-M.	j	m' in W.-M.	m' in M_0	$\gamma \cdot 10^4$ calc.	$\gamma \cdot 10^4$ obs.
Cr^{+++}	19.0	3	15.2	3.04	4.8	5.0
Cr^{++}	24.0	4	20.2	4.04	7.7	7.9
Mn^{++}	29.0	5	25.2	5.04	11.3	11.6
Fe^{+++}	28.9		25.1	5.02		11.5
Fe^{++}	26.0-29.0	4	22-24.4	4.4-4.9	7.7	9.3-11.6
		5	22.6-25.2	4.5-5.04	11.3	
Co^{++}	24.0	4	20.2	4.04	7.7	7.9
Ni^{++} saturated	16.0	3	12.9	2.6	4.8	3.5
Ni^{++} unsaturated	13.0	2	9.5	1.9	2.5	2.3
Cu^{++}	9.1	1	5.26	1.05	1.0	1.1
Cu^{+}	0	0	0	0	0	0

(W.-M.) has a value almost exactly five times smaller than the theoretical "Bohr-magneton." *Weiss* obtained his values for the atomic magnetic moments of ions in solutions from the measured susceptibilities χ by means of *Langevin's* formula based on classical statistics

$$(3) \qquad 4\pi\chi = \frac{Nm^2}{3kT}$$

Where N denotes the number of atoms (or ions) in unit space, k Boltzmann's constant and T the temperature. *Cabrera* uses the same method of theoretical analysis and derives values of m in Weiss-magnetons as units.

It has been, however, pointed out by *W. Pauli* (*Phys. Zeitschr.* 1920, xxi, p. 615) that the statistics of the quantum theory lead to a different result and that *Langevin's* formula must be replaced by the new one

$$(4) \qquad 4\pi\chi = \frac{(j+1)\,(2j+1)}{6j^2}\,\frac{Nm'^2}{kT}$$

We see that from the point of view of the quantum theory the values m derived by *Cabrera* need a correction, and that the new value m' will be $m' = \alpha m$, where the correction factor α has the form

$$(5) \qquad \alpha = \frac{j}{\sqrt{(j+1)\,(j+\tfrac{1}{2})}}$$

j:	1	2	3	4	5	6
α:	0.577	0.730	0.802	0.842	0.870	0.890

The application of these considerations to Cabrera's material is contained in a following table. The second column gives the values of m in Weiss-magnetons, which this author considers as the best mean of the results of different observers. It may be remarked that some of the authors find values lying rather far from whole numbers, so that the integral nature of this quantity does not seem quite assured to the unprejudiced observer. In order to find the corrected value m', it is necessary to make a hypothesis as to the number j of Bohr-Magnetons in the atom. This hypothetical j is given in the third column, while the fourth contains the result of the correction in Weiss-Magnetons, from which the value of m' in Bohr-Magnetons is obtained by dividing by five (fifth column). The agreement of the final result of the fifth column with the hypothetical j of the third gives a measure of the extent to which the hypothesis was justified. It will be remembered that j represents the number of Bohr-Magnetons m_0 contained in an atom, so that the third column gives our hypothesis as to this number, while the fifth contains the same number as derived from Cabrera's experimental material. We see that there exists an apparent discrepancy in Ni^{++} in saturated salts and for Fe^{++}. However, the case of Fe^{++} is without any significance, because the uncertainty of the experimental values is here so large as to prevent any conclusions. The rest of the paramagnetic salts shows an excellent agreement with the quantum theory.

There may be suggested still another and more convenient method for checking these results. By means of formula (3) we can compute the susceptibilities (referred to the grammatom of material) corresponding to the individual integer j. We have tabulated these values of the susceptibility in the sixth column, while in the seventh the actually measured values are given for comparison.

Again we see that a discrepancy larger than the limits of experimental error exists only for Ni. Physicists engaged in magnetic research would therefore promote the development of the theory of quanta by paying particular attention to the ions Fe^{++} and Ni^{++}.

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Studies by a new method of analysis of complex crystal structures and normally and abnormally reflected secondary X-rays characteristic of chemical elements in crystals: GEORGE L. CLARK. (1) A new ionization spectrometer method of analyzing crystals has been designed to be applicable to variable parameter systems (triclinic, monoclinic, orthorhombic), and to be independent of previous determinations of structure, number of molecules per unit, wave-length and densities. Wave-lengths producing particular effects are accurately evaluated by an experimental determination of the critical voltage in the quantum law $Ve = hc/\lambda$. (2) By this method crystals and powders of the following compounds have been

studied and structures determined; KI, simple cubic, $d = 3.532$; CsI, cube-centered, $d = 4.562$; KI_3, cube-centered slightly distorted into monoclinic prism, $d_{100^b} = 4.70$; CsI_3, orthorhombic, $d_{100} = 4.50$, $d_{010} = 6.43$, $d_{001} = 7.02$, 3 I atoms on body diagonal; $CsIBr_2$, orthorhombic, $d_{100} = 4.26$, $d_{010} = 5.91$, $d_{001} = 6.90$, CsI and Br planes equally spaced for 100 series. (3) New phenomena of great importance have been incidentally discovered: (1) the production of secondary X-rays characteristic of elements I, Cs and Br in crystals, appearing alone in spectra when the potential is below that required for the generation of the line spectrum of the target element tungsten, obeying the law $n\lambda = 2d \sin \theta$, and enabling distinction between Cs and I in the same crystal; (2) in addition the abnormal reflection of characteristic Iodine rays from KI, varying in direction in an anomalous fashion with the angle of incidence, corresponding to no one set of planes, not obeying the usual laws and unexplainable by present theories. These things have direct bearing upon the mechanism of X-ray reflection and excitation, orientation, damping, electronic structure, mutual atomic effects.

Electron positions in crystals: MAURICE L. HUGGINS. A careful analysis of the various conceivable ways in which the valence electrons or electron orbits might be distributed in crystals such as C, Si, Ge, SiC, ZnS, AgI, AgCl, NaCl, etc., based solely on the assumptions: (1) that the arrangements of atomic centers in the crystals have been correctly determined by means of X-rays, (2) that these arrangements are due to the attractions and repulsions between nuclei and electrons, and (3) that the number of valence electrons is 1 for Na and Ag, 2 for Zn, 4 for C, Si and Ge, 6 for S, 7 for Cl, Br and I, etc., shows that the valence electrons in these compounds *must* be in relatively fixed positions *in pairs at tetrahedron corners* around the kernel of each electronegative atom. In some cases they also form a tetrahedron of pairs around the kernel of each electropositive atom. This conclusion is in accord with the observation that, assuming only (1) and (3) above, the number of valence electrons in every crystal containing electronegative atoms whose structure has been determined by X-rays, excepting only Cr, Mo, Ta, W and the trihalides, is precisely the number required for a tetrahedron of pairs around the kernel of each electronegative atom. Furthermore, this result is predictable, without any new assumptions being necessary, from the system of atomic structures previously proposed (*J. Phys. Chem.*, xxvi, 601, 1922).

The determination of crystal structures without X-rays: MAURICE L. HUGGINS. A study of the arrangements of valence electrons in crystals whose atomic arrangements have been determined by means of X-rays has made it possible to predict the structures of many crystals and in some cases to verify these predictions by means of data other than that obtained by X-rays. The crystals considered, besides a number whose structures have been determined by X-rays, include ZnTe, CdSe, CdTe, HgS, HgSe, HgTe, AuCl, BN, BP, AlN, AlP, AlAs, SiO_2 (cristobalite), TiO_2 (rutile and anatase), SnO_2 (cassiterite), MnO_2 (polianite), Mn_2O_3, Mn_3O_4 and Al_4C_3. In each case the assumption that the electrons are in pairs at tetrahedron corners around each atomic kernel (compare preceding abstract), and the available crystallographic data are sufficient to limit the number of possible structures to 1 or 2. These structures are checked up chiefly by comparisons of interatomic distances.

Further interesting tracks of alpha particles in gases (lantern): R. W. RYAN AND W. D. HARKINS.

A new relation concerning the periodic system of the isotopes (lantern): W. D. HARKINS.

On the disintegration of atoms: W. D. HARKINS.

The separation of mercury into isotopes in a steel apparatus (lantern): W. D. HARKINS AND S. L. MADORSKY.

The relation between thermoelectric force and the rate of evaporation of electrons from hot filaments: WORTH H. RODEBUSH. The equation derived by the author (*Journal A. C. S.*, March, 1923) for rate of evaporation gives values for the rate of evaporation of electrons from tungsten molybdenum and titanium filaments at 2000° K. which agree closely with Langmuir's data. Dushman has derived an equation which probably gives even closer agreement with the experimental values, but which does not appear to allow for the existence of thermoelectric force. From the author's equation, with the aid of thermodynamics, a relation is derived between thermoelectric force and the rate of evaporation of electrons, and it appears possible to calculate the latter by measurement of the former at high temperatures. The assignment of specific heat to the conducting electrons in a metal appears to be an assumption not required by thermodynamics and contradicted by experimental evidence.

Absolute potential measurements: H. P. CADY AND GEORGE LYNN. The work was done by using a quadrant electrometer, one pair of quadrants being composed of mercury and the other the solution under investigation. The following is a summary of the results:

Trial No.	Method	Potential of Hg				
		Calomel			Hg_2SO_4	
		Sat.	N/10 KCl	N KCl	N KCl	N/10 KCl
1	Zero		—.157	—.283		
2	Deflec.		—.080			
3	Zero			—.170		
4	Deflec. (siphon)			—.212		
5	Deflec.	+.150				
6	Deflec.	+.175				
7	Deflec.	+.215	+.040	—.025		
8	Deflec.				+.050	+.097
9	Deflec.				—.200	—.160
10	Deflec.				—.085	—.047

None of the results approaches the value +.56 volts for the normal calomel electrode, but rather, with one exception, indicate that the mercury is negative to the solution and the values found for the N/10 calomel electrode agree fairly well with those published by Garrison.

A critical discussion of some generally accepted assumptions regarding cells with a liquid junction: GEORGE SCATCHARD. The proof of the elimination of liquid junction potentials by a saturated potassium chloride bridge, even the experimental proof, depends upon the assumption that the activities of the two ions of hydrochloric acid are equal. This assumption leads to considerable liquid junction potentials when the solvent is varied by increasing quantities of sucrose. The generally accepted formula for the electromotive force of a concentration cell with transport involves the assumption that the transport numbers are independent of the gradient of the ionic concentration. With sugar solutions this formula appears to give very erroneous results.

A comparison of electromotive force and freezing-point data: STUART J. BATES. By means of the following equation, the difference (ΔE) between the electromotive forces of cells, such as H_2, HCl (c), AgCl plus Ag, containing the electrolyte at different concentrations, may be calculated from the freezing-points of the solutions involved:

$$\frac{NF\lambda}{RT}\Delta E = \frac{(\theta 1}{(C_1} - \frac{\theta 2)}{C_2)} \int_{C_2}^{C_1} \frac{\theta}{C} \, d \ln C.$$

For HCl observed values of ΔE for the concentrations 0.005 and 0.05 M are Noyes and Ellis 0.11248 volt, Linhart 0.1126. That calculated from the freezing-point data employing the "best values" of Noyes and Falk is 0.1146. For KCl for the same concentrations, MacInnes and Parker found 0.11085, the values caluculated from different series of freezing-point measurements are Jahn 0.11190, Flugel 0.11178 and Adams 0.11207. If, on the other hand, the above equation be employed to calculated freezing-point lowerings from E. M. F. data, the difference between the observed and calculated values is again many times that which the precision of the measurements would indicate. The following equation was found to express the relation between activity coefficients (α) calculated from freezing-point data and the equivalent conductance ratio ($\Lambda/\lambda o$) : ($1 - \alpha$) = K ($1 - \Lambda/\lambda o$). By no means of this relation absolute values of activity coefficients may be calculated: these differ as a rule from those obtained by other methods. The above simple relation indicates that the factor or factors which operate in solution to decrease the equivalent conductance cause a proportional decrease in the activity coefficient.

The potential of the chlorine electrode in the presence of light: GRAHAM EDGAR AND J. A. MORROW. The potential of the chlorine electrode in hydrochloric acid solution has been measured in the dark and under intense illumination by the light of a quartz mercury arc. The light has no effect upon the potential within the limits of error of measurement (about 0.02 m.). This is interpreted to mean that light of the wave lengths employed can have no effect on the *equilibrium* between chlorine, hydrogen and hydrochloric acid gases. This is contrary to many views in the literature.

Luminescence among organo-magnesium halides: S. CALVERT, R. T. DUFFORD AND D. NIGHTINGALE. A study of over seventy Grignard compounds, of which over thirty were luminescent, reveals (1) that magnesium is necessary; (2) that ether is not; (3) that most aliphatics are inactive, while most aromatics are; (4) that substituents in the benzene ring affect the light (*a*) by their position, (*b*) by their chemical nature, (*c*) and not by their weight; (5) several very bright reactions are found, one, p. chlor. brom. magnesium benzene (MgC_6H_4ClBe), being probably the brightest on record. To give luminescence the Grignard must be derived from compounds containing halogen directly attached to unsaturated carbon.